

## Effects of urea-N fertilizer dosage supplemented with Ipil-Ipil tree litter on yield of rice and insect prevalence

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**Abstract:** The present study was undertaken to determine the effects of different levels of urea-N fertilizer in addition to ipil-ipil tree litter on yield of rice and insect prevalence. The field study was conducted at the Agroforestry Field Laboratory, Bangladesh Agricultural University, Mymensingh during July-December 2004. The treatments included 0, 90, 180, and 270 kg urea per hectare. All four treatments received five tons ipil-ipil tree litter per hectare. The experiment was laid out in a randomized complete block design (RCBD) with four replications. The results showed that the different treatments significantly influenced the yield and yield component viz. total tillers/hill, effective tillers/hill, filled grains and unfilled grains/panicle. The highest yield of 4.62 t·hm<sup>-2</sup> with an increase of 21.57% over the control was recorded in treatment 180 kg urea·hm<sup>-2</sup>, which was statistically similar to treatment 90 kg urea·hm<sup>-2</sup>. The prevalence of insects viz. green leafhopper, brown plant hopper, rice bugs, leaf folder and stem borers were mostly correlated with N-levels. The prevalence of insects in general gradually increased with the increase of N. Therefore, this study suggests that the combined application of organic materials (tree litter of ipil-ipil) and N-fertilizer of 90 kg·hm<sup>-2</sup> may produce good yield while minimizing insect prevalence in the rice field.

**Keywords:** Nitrogen fertilizer dosage; Insect prevalence; Rice; Ipil-ipil; *Leucaena leucocephala*

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### Introduction

Leaf litter is a very important organic source of soil fertility. The decomposition of leaf litter influences the amount of N available for plant uptake. Leaf litter supplies carbon, nitrogen, phosphorus, potassium and other nutrients in the soil that are also important indicators of soil productivity and ecosystem health. Therefore, if tree litter can be utilized as a source of organic matter for rice cultivation then chemical fertilizers supply, like urea can be reduced. Incorporation of green manure crops into the soil has been shown to increase organic carbon, total nitrogen, and crop yield (Gu and Wen 1980). Researchers in the Bangladesh Rice Research Institute (BRRI) reported an increase in yield of approximately 50% following incorporation of green manure (BRRI 1983 & 1984). Bhuiya and Akhand (1982) reported that the application of organic materials in combination with chemical fertilizers responded better than the organic materials alone. Green-manuring from *Sesbania rostrata* can save a substantial amount (50%) of chemical nitrogen in rice production (Bhuiyan, 1984; Rabindra *et al.* 1989; Thangaraju and Kannaiyan 1990). Incorporation of *Leucaena* green manure increased N uptake throughout the vegetative period regardless of the mineral N level. At all N rates grain yield increased significantly following *Leucaena* incorporation; 8 t·hm<sup>-2</sup> *Leucaena* manure were almost as effective as 88 kg N (Zoysa *et al.* 1990).

Currently farmers are being encouraged to develop agroforestry systems. Ipil-ipil, (*Leucaena leucocephala*) is one of the most versatile species of all tropical trees because of its exceptionally high rate of growth, ability to fix nitrogen and high nutritional value as feed for livestock. High rates of nitrogen fixa-

tion (100-500 kg N/ha/yr), which contribute to high foliar N content (4.3% dry wt.), and rapid decomposition of its foliage make ipil-ipil an excellent mulch (surface application) or green manure (incorporated) crop. In addition to inorganic nutrients, ipil-ipil mulch/green manure can increase soil organic matter (Duke 1983).

Nitrogen inputs not only increase plant productivity but also increase the availability of insect resources and increase the number of insect individuals and possibly the number of insect species (Hurd *et al.* 1971; Hurd and Wolf 1974; Kirchner 1977; Vince *et al.* 1981; Prestidge 1982; Sedlacek *et al.* 1988; Siemann 1998). About 175 species of insect have been recorded as rice pests (BRRI, 1985) and of those 20–30 species are economically important (Miah and Karim 1984). The estimated annual loss of rice in Bangladesh due to insect pests and diseases amounts to 1.5 to 2.0 millions tons (Siddique 1992). The average loss due to insect pests in Bangladesh is about 18% of the expected rice crop yield per year (Alam *et al.* 1983). In the light of the above perspective, the present experiment was undertaken to investigate the effects of urea-N fertilizer along with ipil-ipil tree litter for profitable rice cultivation.

### Materials and methods

The study was conducted at the Field Laboratory of the Agroforestry Department, Bangladesh Agricultural University (BAU), Mymensingh, Bangladesh, from July to November 2004. Generally, the soil was non-calcareous dark grey flood plain, having pH 6.5 to 6.8, organic matter content 1.14%, total nitrogen 0.085% and C/N ratio 13.5. The land is moderately well drained with silty loam texture (FAO 1988). Moderately high temperatures occurred during the months of July to November 2004. The tested cultivar BR11 (Mukta) developed by the BRRI was used for this study. BR11 is a quick growing high yielding transplanted rice cultivar with an average yield of 5.5 to 6.5 t·hm<sup>-2</sup> under proper management (BRRI, 1991). BR11 performs best in

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sandy loam to clay loam soil. The experiment was laid out in a randomized complete block design with four replications. The plot size was 4m x 2.5 m. The treatments were as follows. All treatments received five tons of ipil-ipil litter per hectare.

$N_0$  = 0 kg urea per hectare (control)

$N_1$  = 90 kg urea per hectare (41 kg N)

$N_2$  = 180 kg urea per hectare (82 kg N)

$N_3$  = 270 kg urea per hectare (124 kg N)

The twigs and leaves of ipil-ipil were collected from locally grown trees and soil surface and incorporated into the test area on 22 July 2004. The ipil-ipil litter was incorporated at least 15 days before transplanting. A power tiller was used for initial preparation of the field in the last week of June. After a heavy rain in the first of July, the land was puddled thoroughly by ploughing and cross ploughing followed by laddering. Weeds and stubble were cleared and the land was finally leveled and prepared by laddering. Urea was applied three times at 15, 30 and 50 days after transplanting. All plots received an initial application of Triple Super Phosphate (TSP) @ 90kg·hm<sup>-2</sup>, Muriate of Potash (MOP) @40 kg·hm<sup>-2</sup>, Gypsum @ 60 kg·hm<sup>-2</sup> and Zinc sulphate @ 10 kg·hm<sup>-2</sup> which was incorporated during the final land preparation (BRRI, 1998). On 6th August 2004, two or three thirty-five day-old BR11 seedlings were transplanted per hill in 15cm×25 cm spacing. Plant height, total number of tillers/hill, effective tillers/hill, panicle length, 1000-grain weight and yield were recorded at final harvest.

Five major insect species viz. green leaf hopper, stem borer (Fig. 1), brown plant hopper, leaf folder (Fig. 3) and rice bug (Fig. 2) were sampled as described below:



Fig. 1. Stem borer infestation showing white head symptom of rice

#### Green leafhoppers and Brown plant hoppers

Sweeping was done at the plant canopy level between plants and as close to the basal region as possible. Each 10 m<sup>2</sup> plot was divided into 10 sub-sections consisting of 1m<sup>2</sup> and insects were collected by taking one sweep from each sub-section. The collected samples were stored in jars and counted in the laboratory.

#### Rice Bug

Rice bugs were counted in the morning because they are not active at that time. The numbers of bugs were recorded by choosing 1-m<sup>2</sup> area at 4 different sites in each plot.

#### Damaged leaves by leaf folder

The prevalence of leaf folder was assessed based on the percentage of leaves infested. Twenty hills were selected randomly

in each plot and the number of infested leaves was recorded. The percent of leaf folder damaged leaves were calculated by the following formula.

$$\text{Damaged leaves(\%)} = \frac{\text{No. of damaged leaves/20 hills}}{\text{Total no. of leaves/20 hills}} \times 100$$

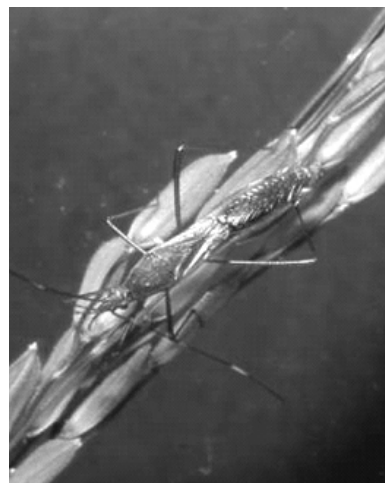


Fig. 2. Rice bug sucking sap from the grain



Fig. 3. Rice leaf folder infested leaf

#### Stem borer (% White head)

The prevalence of stem borer was determined based on the percentage of white head symptoms found throughout the plot. Twenty hills were selected randomly from each plot and the numbers of white heads were recorded. The damage was assessed using the following formula from Onate (1965).

$$\text{White heads(\%)} = \frac{\text{No. of white heads}}{\text{Total no. of panicles observed}} \times \frac{\text{No. of infested hills}}{\text{Total no. of hills observed}} \times 100$$

#### Relative abundance of insects

Relative abundance of insect pests was calculated using the following formula:

$$\text{Relative abundance (\%)} = \frac{\text{Total number of each insect species}}{\text{Total number of all insect species}} \times 100$$

Duncan's new multiple range tests was used for data analysis. The percentage data were transformed by arc sine or square-root transformation depending on the range of percentage data. Data ranging from 0%–30% and 70%–100% were transformed by square-root transformation and that of 30%–70% by arc sine (Gomez and Gomez, 1984).

## Results

Nitrogen fertilizer and tree litter had a significant effect on yield and most yield components of rice. The highest number of total tillers hill<sup>-1</sup> was observed in the 270 kg urea ·hm<sup>-2</sup> treatment but the total number of effective tillers hill<sup>-1</sup> was highest in the 180 kg urea·hm<sup>-2</sup> treatment, which was statistically identical with the 90 kg urea ·hm<sup>-2</sup> treatment. The total number of filled grains per panicle was also highest in treatment 180 kg urea·hm<sup>-2</sup> but

statistically similar with 270 kg urea·hm<sup>-2</sup> and 90 kg urea·hm<sup>-2</sup>. The lowest number of filled grains panicle<sup>-1</sup> (85.03) was observed in 0 kg urea·hm<sup>-2</sup>. The highest yield (4.62 t·hm<sup>-2</sup>) was obtained from 180 kg urea·hm<sup>-2</sup> treatment which was statistically similar with 270 kg urea·hm<sup>-2</sup> and 90 kg urea·hm<sup>-2</sup> treatment (Table 1).

The prevalence of all the major insect pests tended to increase with increasing doses of N-fertilizer. The highest prevalence of all insects was found in the treatment of 270 kg urea ·hm<sup>-2</sup> (except for the case with white head). The population of rice bug was not significantly affected by different treatments though the highest (2.33) prevalence was found in 270 kg urea·hm<sup>-2</sup> treatment. The percentage of damaged leaves was also found higher with 270 kg urea·hm<sup>-2</sup> treatment. The higher percentage of white head was found with 180 kg urea·hm<sup>-2</sup> treatment which was statistically similar to that of 270 kg urea·hm<sup>-2</sup> treatment (Table 2). During the rice growing season, the relative prevalence of insect in the rice field environment was ranked in the order of green leafhopper > Brown plant hopper > Rice bug (Table 3).

**Table 1. Effect of urea nitrogen supplemented with ipil-ipil tree litter on yield and yield contributing characters of rice cv. BR11. All treatments received five tons of ipil-ipil per hectare**

Treatment Urea in kg ha <sup>-1</sup>	Plant height (cm)	Total no. of tillers/hill	Total no. of effective tillers/hill	Length of Panicle (cm)	Total no. of filled grain/panicle	Total no. of unfilled grain /panicle	1000-grain weight	Yield (t·hm <sup>-2</sup> )
0	99.24	10.00 c	7.00 b	20.26	85.03 b	49.34 a	21.01	3.80 b
270	104.42	13.33 a	8.00 b	19.23	109.53 a	46.28 a	23.24	4.30 a
180	102.18	12.00 b	10.67 a	20.89	112.58 a	35.69 c	21.67	4.62 a
90	99.62	12.00 b	9.33 ab	19.19	106.26 a	40.43 b	21.48	4.30 a
Level of significance	NS	**	**	NS	**	**	NS	**
CV(%)	4.47	4.88	13.06	4.74	4.22	5.08	5.40	4.25

\*\* =Significant at 1% level. NS =non-significant

**Table 2. Effect of urea nitrogen supplemented with ipil-ipil tree litter on insect pest prevalence in rice cv. BR11. All treatments received five tons of ipil-ipil per hectare**

Treatment Urea in kg ha <sup>-1</sup>	Green leaf (heads·m <sup>-2</sup> )	Hopper	Brown plant Hopper (heads·m <sup>-2</sup> )	Rice bug (heads·m <sup>-2</sup> )	%white head	% Damaged leaves
0	32.33 b		1.33 c	2.00	.032 b	.003b
270	45.67 a		4.33 a	2.33	.058 a	.008a
180	38.33 b		3.00 b	1.33	.069 a	.004b
90	38.00 b		2.33 bc	1.68	.028 b	.004b
Level of significance	*		**	NS	**	**
CV(%)	8.97		20.99	48.96	11.90	20.32

\*=Significant at 5% level; \*\* =Significant at 1% level; NS =non-significant

**Table 3. Relative abundance of insect pests in rice cv. BR11**

Insects	Total No. of insects	Relative abundance (%)
Green leaf hopper	463.00	89.38
Brown plant hopper	33.00	6.37
Rice bug	22.00	4.247

## Discussion

We found that urea-N fertilizer supplemented with ipil-ipil tree litter significantly increased yield and some yield components of rice. The highest number of tillers per hill occurred with 270 kg urea·hm<sup>-2</sup> (124 kg N). But the total number of effective

tillers occurred with 180 kg urea·hm<sup>-2</sup> (82 kg N). These results are in agreement with Apostol (1989) who reported that organic and inorganic fertilizer increased the productive tillers per hill of rice. The 180 kg treatment was statistically identical with the 90 kg urea·hm<sup>-2</sup> (41 kg N) treatment. The total number of filled grains panicle<sup>-1</sup> was highest at 180 kg·hm<sup>-2</sup> and this was statistically similar to the 270 kg urea·hm<sup>-2</sup> and the 90 kg urea·hm<sup>-2</sup> treatment. Kant and Kumar (1994) reported that the increasing amendments with farm yard manure (FYM) increased the number of grains per panicle. Similarly Akter *et al.* (1993) reported that the application of green manure with chemical fertilizer was found to produce significantly higher yield parameters than with chemical fertilizer only.

The highest yield ( $4.62 \text{ t} \cdot \text{hm}^{-2}$ ) was obtained with  $180 \text{ kg urea} \cdot \text{hm}^{-2}$  which was statistically similar to  $270 \text{ kg urea} \cdot \text{hm}^{-2}$  and  $90 \text{ kg urea} \cdot \text{hm}^{-2}$  treatment. Jeyaraman and Purushothaman (1988) reported similar results. They found that  $10 \text{ t}$  ipil-ipil green manure combined with  $50$  and  $75 \text{ kg N} \cdot \text{hm}^{-2}$  gave grain yields of  $4.3$  and  $4.8 \text{ t} \cdot \text{hm}^{-2}$ , respectively compared with  $2.8 \text{ t}$  with no N,  $3.6 \text{ t}$  with green manure alone and  $4.3 \text{ t}$  with  $100 \text{ kg} \cdot \text{hm}^{-2}$  N. Zoysa *et al.* (1990) reported that  $8 \text{ t} \cdot \text{hm}^{-2}$  *Leucaena leucocephala* green manuring was almost as effective as  $88 \text{ kg}$  chemical N. Rathert and Nammuang (1992) studied the responses to inorganic fertilizer and green leaf manuring with *Leucaena leucocephala* loppings and reported that applying  $30 \text{ kg} \cdot \text{hm}^{-2}$  N as loppings was similar to  $50 \text{ kg} \cdot \text{hm}^{-2}$  inorganic N in its effects on rice yield.

The prevalence of all the major insect pests tended to increase as urea-N increased. It is likely that use of excessive N-fertilizer with tree litter can lead the plant to become more succulent and consequently more attractive to insects. High levels of nitrogen can stimulate early vegetative growth leading to mutual shading. Mutual shading can reduce the photosynthetic activity and result in an unfavorable nitrogen/carbohydrate balance leading to a higher insect pest infestation (Ito and Sakamoto 1942). Our results agreed with the findings of several researchers. According to Prasad *et al.* (2004) leaf folder (*Cnaphalocrocis medinalis*) and yellow stem borer (*Scirpophaga incertulas*) were greatest at  $200 \text{ kg N} \cdot \text{hm}^{-2}$  and lowest at  $0 \text{ kg N} \cdot \text{hm}^{-2}$ . In another study Mustahafa and Potty (2001) reported that leaf roller incidence increased with the increasing N rates up to  $70 \text{ kg N} \cdot \text{hm}^{-2}$ . While Saroja *et al.* (1987) also reported that with increasing nitrogen levels resulted in an increase in incidence of rice leaf folder occurred.

Our data suggest that the combination of  $5 \text{ t}$  tree litter of ipil-ipil with  $90 \text{ kg} \cdot \text{hm}^{-2}$  N-fertilizer ( $41 \text{ kg N}$ ) would be the best combination for maximizing rice yield and reducing insect prevalence in rice under the growing conditions reported here.

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